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# Teachers' Perceptions About Climate Change: A Comparative Study of Public and Private Schools and Colleges in Bangladesh

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This study examines school and college teachers' perceptions about climate change, taking into account academic backgrounds and experiences with the impacts of climate change. The study included 95 teachers from three schools and colleges (two private and one public) in the city of Sylhet, Bangladesh. The results show that most teachers have heard about climate change and understand what it means. Most also perceive that temperatures in Bangladesh are rising or fluctuating and that rainfall is falling or fluctuating. The chi-squared test shows that teachers' perceptions about climate change depend on whether their educational institution is private or public and whether they believe their home locality is at risk of extreme weather events (EWE). Binary and multinomial logistic regressions were used to specifically examine the impact of teachers' academic backgrounds and their previous experiences with extreme weather events on their perceptions about climate change. The results of the binary logistic regression show that educational institution type and the teaching levels (SSC: Secondary School Certificate or HSC: Higher Secondary School Certificate; or both levels) in which the teacher teaches are two significant predictors of teachers' perceptions about temperature change. The multinomial logistic regression analysis of perceptions about changes in precipitation shows that there is a statistically significant effect for factors including type of educational institution, bachelor-level study area, hometown vulnerable to EWEs, and environmental or climate-change-related courses taken.

**Keywords: academic backgrounds, experiences with the effects of EWEs, areas vulnerable to EWEs, teachers' climate change perception, type of educational institution, schools and colleges, Bangladesh**

## INTRODUCTION

Bangladesh, a South Asian country located to the east of India on the Bay of Bengal, is one of the countries in the world most vulnerable to the effects of climate change. Various factors, including high population density, poverty, and inadequate access to water supply, sanitation, energy, and health services, all contribute to the country's physical vulnerability

[Intergovernmental Panel on Climate Change (IPCC), 2007; Pouliotte et al., 2009; Islam et al., 2014; Huq and Rabbani, 2015]. According to Rahman et al. (2018), the trend in 1971–2010 was increasing mean temperatures (0.19°C decade-1), mean minimum temperatures (0.17°C decade-1), and mean maximum temperatures (0.21°C decade-1). The average temperature for the country varies between 19.20 and 22.00°C in winter and between 29.70 and 31.30°C in summer. Increasing minimum temperatures is likely to affect the northwestern and northeastern parts of the country and increasing maximum temperatures its southeastern and south-central regions (Rahman et al., 2018). Seasonal and geographical variations in precipitation are also observed in Bangladesh. Annual rainfall is than 1,400 mm in the west-central region, while the northeast and southeast regions each receive more than 3,000 mm annually. During the monsoon season, intense and heavy rains account for about 80% of all rainfall (Karmalkar et al., 2012; Thomas et al., 2013). Climate change-related issues such as gradual temperature rise and changes in rainfall patterns have had a significant impact on various sectors in Bangladesh, including agriculture, water resources, and public health (Kabir et al., 2009; Garai, 2014). Changes in temperature and rainfall patterns affect agricultural productivity. For example, minimum temperature, maximum temperature, and rainfall affect rice production variability in Bangladesh both positively and negatively (Sarker et al., 2012).

According to Van den Ban and Hawkins (2000), perception is the process by which we receive information or stimuli from our environment and transform them into psychological awareness in order to construct meaningful experiences of the world. Many factors, including education and experience, influence the accuracy of perception, and accuracy is crucial because actions taken based on incorrect perceptions can have negative consequences (Alam et al., 2017; Tripathi and Mishra, 2017; Foguesatto et al., 2018). It is widely recognized that humans are excellent observers of their environment (Salick et al., 2009; Turner et al., 2009). The concept of climate change is highlighted in several recent studies focusing on public perceptions about climate change (Dessai and Sims, 2010; Tiwari et al., 2010; Huda, 2013; Yu et al., 2013; Manandhar et al., 2014; Kabir et al., 2016). Perceptions about climate change, according to Weber and Stern (2011), refers to how people view and assess climate change in all its facets. These perceptions are localized and influenced by people's beliefs and attitudes (Brody et al., 2008; Bunce et al., 2010; Speranza et al., 2010; Carlton and Jacobson, 2013). In terms of the socio-demographic dimensions of perceptions about climate change, most studies have been conducted in developed countries (Salick and Byg, 2007), and very few in developing countries. An example of the latter is Haq and Ahmed (2017), who examined this issue in Bangladesh. Students' and teachers' perceptions of climate change at different levels of institution (school, college, university) may vary depending on their academic background and previous experiences with the impacts of extreme weather events (EWE). How people perceive climate change is crucial, as people who believe in the reality of climate change are more likely to support initiatives aimed at preparing for it (Bateman and O'Connor, 2016; Mildenberger et al., 2019).

A number of studies have examined students' and teachers' perceptions of climate change at the secondary or university level (e.g., Lambert and Bleicher, 2013; Boon, 2016; Stevenson et al., 2016; Arini et al., 2017; Higde et al., 2017; Meilinda et al., 2017; Ceyhan and Mugaloglu, 2020; Chowdhury et al., 2021). Many studies indicate that teachers who are influenced by their beliefs in both the content they teach and the pedagogy they adopt (Mansour, 2013; Glackin, 2016). Teachers' beliefs indeed influence how they present the topic of climate change in the classroom (Seow and Ho, 2016). For example, when teachers are confident in teaching subjects related to climate change, students are demonstrate more interested in these subjects (Stevenson et al., 2016). Mostafa (2007) states that when teachers see environmental destruction as a simple phenomenon, their approach to teaching about it is less reliant on scientific ideas. Over time, this shapes students' perceptions because they see the topic as a matter of memorizing concepts and not as a contextual problem that may threaten their future lives. In Puerto Rico and Florida, researchers studied two groups of science teachers and found that many believe that the loss of the ozone layer is the only cause of climate change (Herman et al., 2017).

This study aims to examine how different types of academic institutions (public or private), disciplinary backgrounds, and experiences with climate change impacts influence teachers' perceptions about climate change. To examine this issue, we asked our participants whether they had noticed any recent significant changes in temperature and precipitation, whether they believed that events such as floods, hurricanes, and droughts were due to climate change, and how they thought the effects of climate change could be mitigated by humans. We also wanted to know the extent to which teachers view climate change as an important issue that they discuss with their colleagues. Since the way teachers from different academic disciplines view climate change and its impacts can have a significant impact on how their students ultimately perceive the issue. In addition, the results of this study can support the implementation of changes in current educational policy and curriculum vis-à-vis climate change. As stated above, the country is highly vulnerable to climate change and faces highly frequent EWEs such as flooding, sea level rise, drought, tropical cyclones, and storm surges (Huda, 2013) and is also economically dependent on natural resources and rain-fed agriculture (FAO, 2007). Meeting these challenges requires adequate courses, training components, and programs for students, teachers, and all educational levels.

The article is organized as follows. It begins with the background and introduction to our research, followed by a presentation of the relevant literature and conceptual framework for this study. The methodology section describes the research methods used as well as the process to select the target population and educational institutions. Then the results are analyzed to understand teachers' perceptions about climate change and how they differ according to various sociodemographic factors. Finally, we conclude with a discussion and conclusions section in which we highlight the main limitations of this study and make suggestions for further studies.

# METHODOLOGY

## Literature Review

Climate change is an important component of global educational goals, particularly in terms of curricula, as represented, for example, the *Next Generation Science Standards* (NGSS Lead States, 2013) in the USA and *National Curriculum in England: Science Programmes of Study* (Department for Education, 2015). In addition, Japan, along with a number of other countries, has begun to incorporate the principles in UNESCO's *Climate Change Education for Sustainable Development* (UNESCO, 2010) into its curricula (Japanese National Commission for UNESCO, 2012). To promote climate literacy among current and future generations, educating children can be a useful strategy (Ennes et al., 2021). Students are particularly motivated by their teachers' lessons. This means that the accuracy of teachers' perceptions about climate change is very important to the younger generations' awareness of climate change. There are many factors that can affect teaching and learning about climate change, such as political controversies (Kahan et al., 2012; Plutzer et al., 2016), lack of educational prerequisites (Arslan et al., 2012; Hestness et al., 2014), and misconceptions (Breslyn et al., 2017). A recent 2019 Oxfam climate change survey found that 69% of UK teachers want more climate education in schools, and 70% agree with drastic changes to UK legislation to bring the education system up to speed (YouGov, 2019). It is clear in many studies that education is important for addressing climate change (Huda, 2013; Smith et al., 2014; Taylor et al., 2014). In his study, Eze (2020) found that teachers with a master's degree have a higher mean score for climate change awareness than those with a bachelor's degree; in contrast, the latter show a higher propensity to engage in pro-environmental behaviors than the former.

Ayanlade and Jegede (2016) showed that environmental science graduates had more experience with climate change in the classroom than those in other disciplines in Nigeria. Beck, Sinatra and Lombardi's (2013) study of two universities in the southwestern United States found that science, agriculture, and natural resources teachers had a much deeper understanding of climate change than engineering, business, and management teachers. Similarly, Mugambiwa and Dzomonda's (2018) study of students at a South African university found that science and agriculture students have a deeper understanding of climate change than health science and agriculture students. Hargreaves et al. (2003) also found that people with a science background are more likely to have a better understanding of climate change. In Bangladesh, Haq and Ahmed (2020) also found that a higher proportion of social science students agreed with the idea of anthropogenic climate change than in other sciences, and that students' perceptions of climate change were highly dependent on their experiences with the effects of extreme weather events in their hometowns. Eze (2020) studied both students and teachers from Nigeria and found that academic background was important to participants' awareness of climate change and their willingness to engage in environmentally friendly behaviors; in particular these were higher among social science students than science and humanities students; science teachers showed higher awareness of climate change compared to social science and humanities teachers; and social science teachers showed a comparatively higher mean score for willingness to engage in pro-environmental behaviors. The results of a previous study suggest that higher education institutions adopt new curricula and teaching strategies, as well as new assessment systems, to help students and teachers adapt their behaviors in the face of climate change and its impact on the environment (Ahmed et al., 2021). All in all, it is not easy to understand perceptions about climate change as these are determined by a variety of factors, as shown in **Figure 1**.

## Target Population, Sampling, and Data Collection Techniques

The way teachers perceive climate change or environmental change is fundamental to their students' perceptions about climate change. To uncover this phenomenon this study focused on high school and college teachers. We selected teachers from one public school and two private schools (from a total pool of two public schools and colleges and 17 private schools and colleges) in the *upazila* (county) of Sylhet Sadar in northeast Bangladesh as a sample to investigate how teachers' socio-demographic profile, disciplinary background, and experiences with the impacts of EWEs influence their perceptions about climate change. The public institution selected was the Sylhet Govt. Pilot School and College, one of the oldest schools in Sylhet (founded in 1836). The private institutions were Amberkhana Girls' School and College (established in 1973) and Women's Model School and College (established in 2013). **Table 1** shows a breakdown of the sample by school. the school's name, school type, total number of teachers, number of data collected and response rate of each school in the sample.

This study is designed as a descriptive study, which is the most common form of social research and attempts to describe situations and events in detail (Babbie, 2004). It is based on a primary survey with a self-completed questionnaire. This choice of survey methodology is supported by other studies (Mugambiwa and Dzomonda, 2018; Ahmed and Haq, 2019; Chowdhury et al., 2021; Ahmed et al., 2022). The questionnaire was designed to achieve the objective of this study by focusing on participants' academic background, direct experiences with climate events, involvement in climate/environment-related organizations and academic courses, and other factors. We asked all respondents about their educational and professional background, such as their education level [Secondary School Certificate (SSC), Higher Secondary School Certificate (HSC), undergraduate exams], teaching experience (in years), and level at which they teach (SSC, HSC, or both). We also asked respondents if EWEs had occurred in their region, if they were involved in an environmental organization, and if they had taken courses related to the environment, climate change, or disasters as part of their university curriculum. The study schools and colleges have teachers whose hometown is not Sylhet. We asked them whether they have experience with the effects of EWEs in their hometown, in the form of a yes/no question. The questionnaire also aimed to obtain information about respondents' understanding of and perceptions about

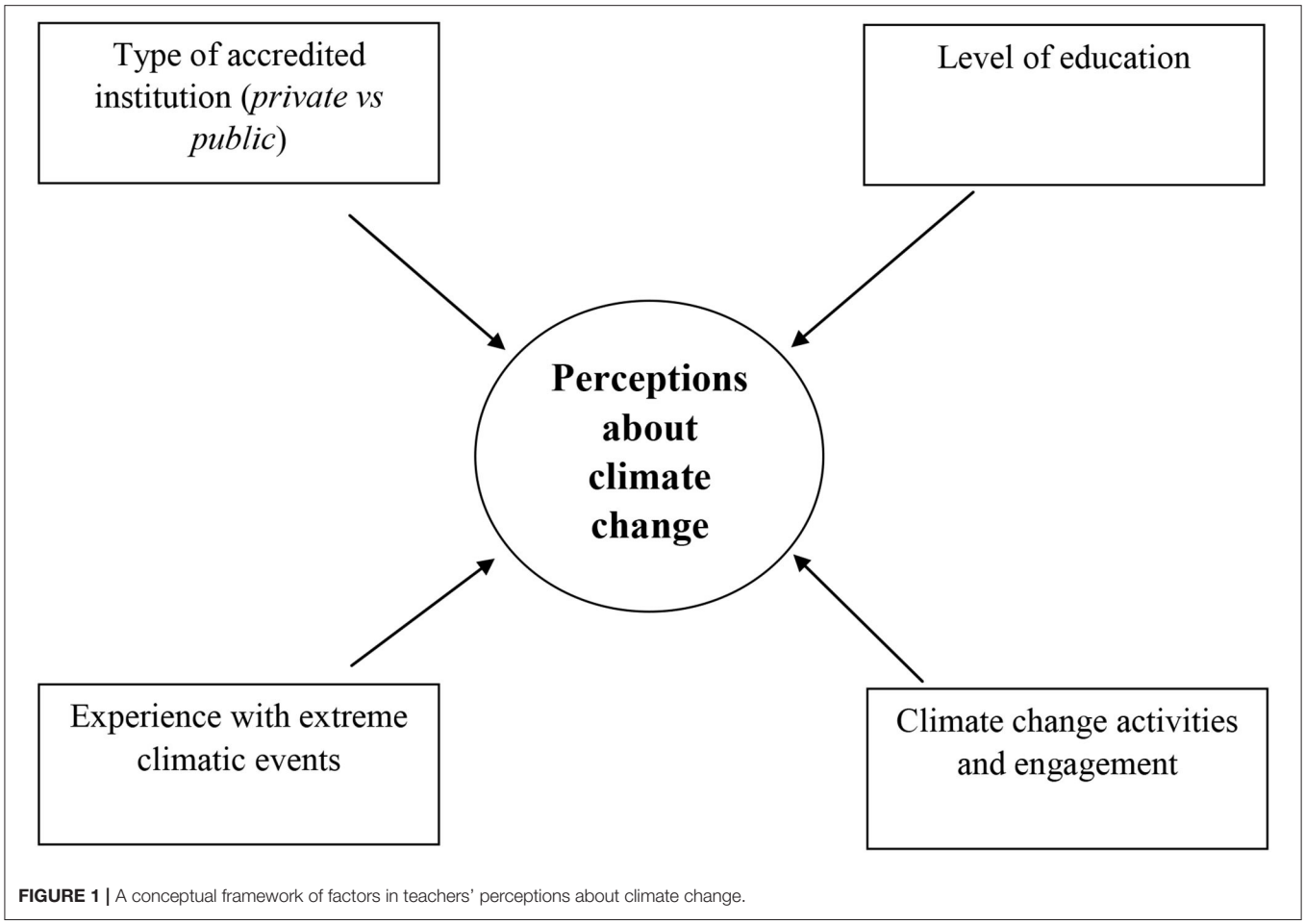


**FIGURE 1 |** A conceptual framework of factors in teachers' perceptions about climate change.

**TABLE 1 |** Breakdown of study schools and participants.

| School/college name | School/college type | Number of teachers on staff | Number of respondents | Response rate |
|---|---|---|---|---|
| Women's Model School and College | Private | 36 | 24 | 67% |
| Amberkhana Girls' School and College | Private | 43 | 33 | 77% |
| Sylhet Govt. Pilot School and College | Public | 51 | 38 | 75% |
| **Total** | | **130** | **95** | **73%** |

climate change. We asked all teachers if they had heard the term "climate change," if they understood its meaning, and if they believed events such as floods, hurricanes, and droughts were the result of climate change; these were also in the form of yes/no questions. We examined how respondents perceive changes in temperature and precipitation, with choices including "increasing," "decreasing," and "fluctuating." The survey was conducted from January 10 to March 15, 2020. We discussed our research objectives and significance with all teachers at the study institutions and asked for their cooperation and participation in the study. We tried to collect data from all the teachers, but this was not possible as some were on vacation and others could not find the time. Finally, we were able to collect data from 95 of the 130 teachers, a response rate of 73%.

## Measurement and Data Analysis

Among others, Verchot et al. (2007), indicate that the potential impacts of climate change include temperature increase, high or low precipitation, droughts, and sea level rise. Rising temperatures, fluctuating precipitation, changes in seasonal rainfall patterns, and frequent and severe EWEs have indeed been observed in Bangladesh and India in recent years (Shukla et al., 2015; Kabir et al., 2016). In this study, perceived temperature changes and perceived precipitation changes are considered

as dependent variables or outcomes. The independent or explanatory variables are type of educational institution, level of education, academic discipline in SSC, HSC, and undergraduate studies, teaching experience (years), departments in which teachers deliver courses, proneness of hometown to EWEs, participation in an environmental organization, and taking a course on the environment or climate change. In this study, we used the chi-squared test to examine the independence between teachers' perceptions about climate change and their type of academic institution, disciplinary background, and participation in a climate change program. The study also used binary logistic regression (BLR) and multinomial logistic regression (MLR) models to determine the effects of explanatory variables on perceptions about climate change. Similar statistical techniques have been used in many other studies on perception (e.g., Brouder and Lundmark, 2011; Gebrehiwot and van der Veen, 2013; Manandhar et al., 2014; Ahmed et al., 2022). We performed multinomial logistic regression (MLR) for the dependent variable of perceived changes in precipitation (increasing, decreasing, and fluctuating) for more than two categories. MLR does not assume normality, linearity, and homoscedasticity. Although our sample size in the study was only 95, there is a guideline for conducting MLR that requires a minimum of 10 cases per independent variable (de Jong et al., 2019). The same ten explanatory variables were included in the MLR as in the BLR. Independent variables included type of educational institution, level of education, majors in SSC, HSC, and bachelor's degree, teaching experience, departments in which teachers teach (SSC, HSC, or both), proneness of hometown to EWEs, involvement in an environmental organization, and courses taken on the environment or climate change.

# RESULTS

## Background Information of the Respondents

The socio-demographic profiles of the respondents are shown in **Table 2**. The table shows that 60% of respondents were from private schools and 40% from public schools; 52.6% were male and 47.4% female; and most (72.6%) were Muslims and the rest (27.4%) belong to other religion. Also, 15.8% are senior and 84.2% early and mid-career; most (83.2%) have a master's degree or higher and 16.8% a bachelor's degree; 35.8 and 64.2% had a background in humanities/business and science, respectively, in their Secondary School Certificate (SSC) examination, while the corresponding percentages for their Higher Secondary School Certificate (HSC) examination were 41.1 and 58.9%, respectively, and at the bachelor's degree level, 60 and 40%, respectively. Of the respondents, 16.8% have extensive teaching experience, i.e., they have been in the profession for more than 20 years; the remaining 83.2% have less than that; and 57.9% were from the locality that they thought was prone to EWE, while 42.1% were not. Only 11.6% of respondents are involved in an environment-related organization, while 88.4% are not. A very small percentage of (9.5%) reported that they had taken a course on climate change, while most (90.5%) had not.

**TABLE 2 |** Background information of the respondents.

| Characteristic | Group | Percentage (*N*) |
|---|---|---|
| Type of institution | Public | 40.0 (38) |
| | Private | 60.0 (57) |
| Educational level | Bachelor's degree | 16.8 (16) |
| | Master's degree or higher | 83.2 (79) |
| SSC discipline | Humanities/business | 35.8 (34) |
| | Science | 64.2 (61) |
| HSC discipline | Humanities/business | 41.1 (39) |
| | Science | 58.9 (56) |
| Bachelor discipline | Humanities/business | 60.0 (57) |
| | Science | 40.0 (38) |
| Currently teaching | SSC or HSC | 76.8 (73) |
| | SSC and HSC | 23.2 (22) |
| Teaching experience | Less than 20 years | 83.2 (79) |
| | 20 years or more | 16.8 (16) |
| Hometown vulnerable to EWEs | Yes | 57.9 (550) |
| | No | 42.1 (40) |
| Involvement in an environmental organization | Yes | 11.6 (11) |
| | No | 88.4 (84) |
| Completed a course related to climate change | Yes | 9.5 (9) |
| | No | 90.5 (86) |

## Respondents' Understandings About Climate Change

**Figure 2** provides an overview of respondents' understanding of climate change issues. The study shows that the term "climate change" is familiar to both public school and private school teachers: 94.7% of the former and 86% of the latter said they had heard of the term, with only 5.3 and 14%, respectively, not having previously heard it. Most private school teachers (75.4%) said they believed temperatures were rising, while, most public school teachers (57.8%) perceived temperatures as fluctuating. There are also differences in opinion among teachers regarding annual precipitation: most public school teachers (57.8%) believe that precipitation is decreasing, compared to 31.6% of public school teachers; 44.7% of public and 22.8% of private school teachers perceive precipitation as fluctuating; more public school teachers (23.7%) believe that annual precipitation is increasing than private (19.3%). Most respondents overall believe that floods are due to climate change (92.1% in public, 93% in private schools); that cyclones are due to climate change (94.7% public, 98.2% private); that droughts are due to climate change (97.4% public, 96.5% private). Respectively, 94.7 and 79% of respondents in public and private schools believe that humans are capable of combating the effects of climate change, with 5.3 and 21%, respectively, not believing this. Most public school respondents (89.5%) said they have talked to their colleagues about climate change; among private school teachers, the percentage was 70.2%.

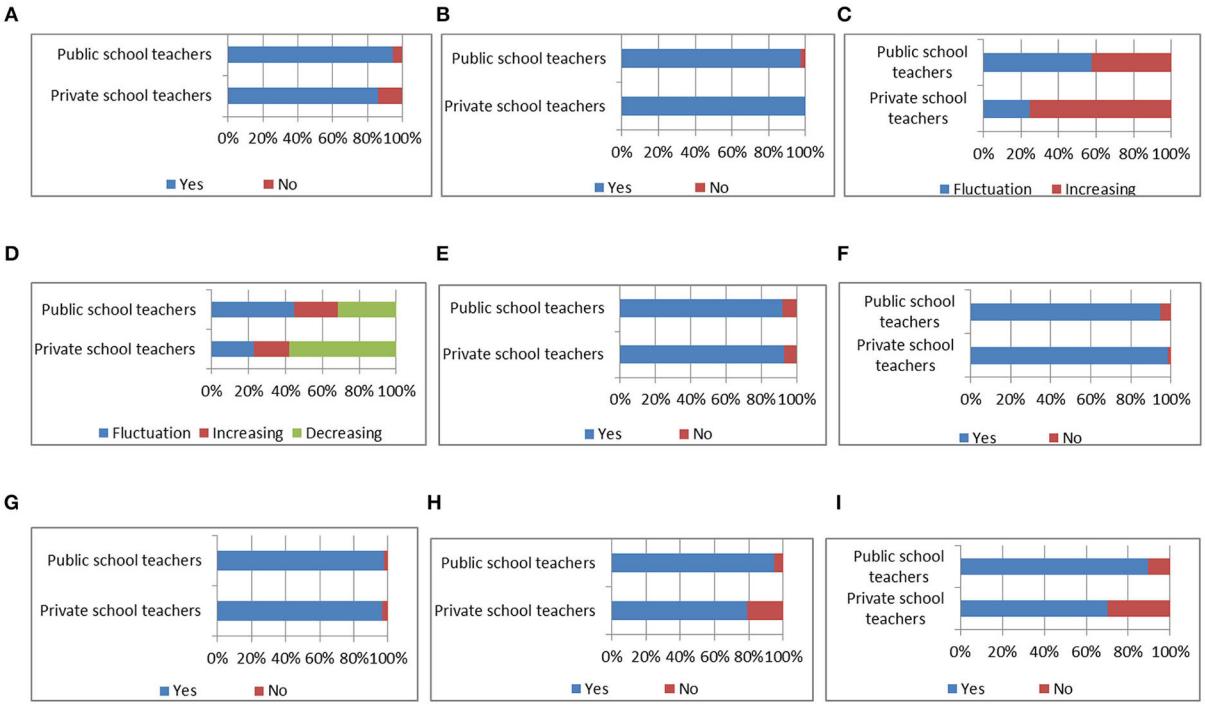


**FIGURE 2 |** Climate change understandings of the respondents. **(A)** Heard the term climate change. **(B)** Know what climate change is. **(C)** Perceive changes in temperature. **(D)** Perceive changes in rainfall. **(E)** Believe floods are the result of climate change. **(F)** Believe cyclones are the result of climate change. **(G)** Believe droughts are the result of climate change. **(H)** Believe humans can combat climate change. **(I)** Discussed climate change with colleagues.

## Teachers' Level of Education, Type of Educational Institution, and Perceptions of Climate Change

### Type of Educational Institutions and Perceptions of Climate Change

Results indicate that there is a statistically significant difference between public and private school teachers in their perceptions about climate change ($p < 0.05$). **Table 3** shows that there are differences between teachers in public and private schools regarding their perceptions about temperature and precipitation changes. Regarding temperature changes, 57.9% of public school respondents perceived temperatures as fluctuating and 42.1% perceived them as increasing, while 75.4% of teachers in private schools viewed them as increasing. Regarding precipitation, 44.7, 23.7, and 31.6% of public school teachers believe that precipitation is fluctuating, increasing, and decreasing, respectively, for private school teachers these figures are 22.8, 19.3, and 57.9%, respectively.

## Academic Backgrounds and Perceptions About Climate Change

### Educational Level

In this study we wanted to see whether the perception of climate change between private and public school teachers independent or dependent on the educational level of the teachers. We divided the educational level of teachers into two groups: bachelor's degree and master's degree or higher. The result illustrates that there is no statistically significant relationship between educational level and perceptions about climate change ($p > 0.05$). In terms of perceptions about temperature change, the majority of teachers overall perceived an increase, but the percentage was comparatively higher among teachers with postgraduate-level education (see **Table 3** for details). For precipitation, the majority of respondents noticed a decrease (48.1% master's or higher, 43.8% bachelor's); some noticed a fluctuation (32.9% master's or higher, 25% bachelor's); others noticed an increase (19% master's or higher, 31.3% bachelor's).

### Study Area at SSC Level

In Bangladesh, there are three departments at the secondary level (grades 9 and 10) or higher secondary level (grades 11 and 12): humanities/business, and sciences. While there are some common courses for all departments, course offerings are specific for each department. We wanted to understand what role the previous educational background of secondary or higher secondary teachers' plays in their perceptions about climate change. Our findings indicate that respondents' perceptions of temperature changes vary significantly by SSC subject area ($p < 0.05$) but for precipitation do not vary significantly by SSC subject area ($p > 0.05$) (see **Table 3**). Results also show that most of the surveyed teachers who took the humanities or business stream at SSC level believe that the temperature is fluctuating (55.9%), for sciences the figure was even higher at 71.1%. Regarding

**TABLE 3 |** Perceptions about climate change according to educational and teaching background.

| Variable | Group | Perceptions about climate change | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Changes in temperature | | Sig. | Changes in rainfall | | | Sig. |
| | | Fluctuating | Increasing | | Fluctuating | Increasing | Decreasing | |
| Type of educational institution | Public | 57.9 % | 42.1% | 0.001 | 44.7% | 23.7% | 31.6% | 0.030 |
| | Private | 24.6% | 75.4% | | 22.8% | 19.3% | 57.9% | |
| Education | Masters or above | 36.7% | 63.3% | 0.597 | 32.9% | 19.0% | 48.1% | 0.531 |
| | Bachelor | 43.8% | 56.3% | | 25.0% | 31.3% | 43.8% | |
| Background in SSC | Humanities/Business | 55.9% | 44.1% | 0.007 | 38.2% | 14.7% | 47.1% | 0.415 |
| | | 27.9% | 72.1% | | 27.9% | 24.6% | 47.5% | |
| | Sciences | | | | | | | |
| Background in HSC | Humanities/Business | 51.3% | 48.7% | 0.025 | 33.3% | 17.9% | 48.7% | 0.822 |
| | | 28.6% | 71.4% | | 30.4% | 23.2% | 46.4% | |
| | Sciences | | | | | | | |
| Background in bachelor | Humanities/Business | 43.9% | 56.1% | 0.142 | 26.3% | 26.3% | 47.4% | 0.210 |
| | | 28.9% | 71.1% | | 39.5% | 13.2% | 47.4% | |
| | Sciences | | | | | | | |
| Teaching experience | Less than 20 years | 36.7% | 63.3% | 0.598 | 30.4% | 21.5% | 48.1% | 0.845 |
| | | 43.7% | 56.3% | | 37.5% | 18.8% | 43.8% | |
| | 20 or more | | | | | | | |
| Teaching level | SSC or HSC | 41.1% | 58.9% | 0.241 | 32.9% | 21.9% | 45.2% | 0.744 |
| | SSC and HSC | 27.3% | 72.7% | | 27.3% | 18.2% | 54.5% | |
| Hometown vulnerable to EWEs | Yes | 43.6% | 56.4% | 0.176 | 34.5% | 10.9% | 54.5% | 0.017 |
| | No | 30.0% | 70.0% | | 27.5% | 35.0% | 37.5% | |
| Involvement in an environmental organization | Yes | 54.5% | 45.5% | 0.226 | 27.3% | 27.3% | 45.5% | 0.856 |
| | No | 35.7% | 64.3% | | 32.1% | 20.2% | 47.6% | |
| Completed an environment-related course | Yes | 66.7% | 33.3% | 0.061 | 55.6% | 22.2% | 22.2% | 0.208 |
| | No | 34.9% | 65.1% | | 29.1% | 20.9% | 50.0% | |

precipitation, teachers with different educational backgrounds in the SSC survey believe it is decreasing; others felt that it is fluctuating (38.2% in humanities and business, 27.9% in sciences) or increasing (14.7% in humanities and business, 24.6% in sciences).

## Study Area at HSC Level

Teachers' perceptions about temperature variability are dependent to their education in humanities, business, or the sciences ($p < 0.05$), but that their perceptions about precipitation variability is found independence to their HSC education ($p > 0.05$). Most teachers who took the HSC exam for humanities or business believe that temperatures are fluctuating (51.3%); the rest believe it is rising (48.7%). In contrast, for the HSC science graduates, a far greater proportion believe they are rising (71.4%); others perceive fluctuations (28.6%). Regarding precipitation, teachers in both section groups believe that precipitation is decreasing (48.7% in humanities and business, 46.4% in sciences); others see it as fluctuating (33.3 and 30.4%, respectively) or increasing (17.9 and 23.2%, respectively).

## Background at the Bachelor Level

We examine whether respondents' perceptions of climate change were related to their undergraduate disciplinary background. The results show there may be independence between undergraduate disciplinary backgrounds and teacher perceptions ($p > 0.05$). 56.1% of humanities and business teachers and 71.1% of science teachers believe temperatures are rising; these figures, respectively, are 43.9 and 28.9% for those who see it as fluctuating. For precipitation, on the other hand, **Table 4** shows that 47.4% for both groups believe it is decreasing; others believe it is fluctuating (26.3% humanities and business, 39.5% sciences) or increasing (26.3 and 13.2%, respectively, sciences).

## Teaching Experience and Teaching Level

In this study, we found respondents' perceptions about climate change may not be related to their teaching experience and levels at which they teach ($p > 0.05$). The majority of teachers believe that temperatures are rising: 63.3% for those with 20 years' teaching experience or more and 56.3% for those with less. Those who saw temperatures as fluctuating stood at 43.7% for the former and 36.7% for the later. Regarding precipitation, those

**TABLE 4 |** Parameter estimates for perceived temperature changes.

| Explanatory variables | Increasing |
|---|---|
| | **Coefficient (Odds ratio)** |
| Type of educational institution | |
| Public (ref = Private) | −3.060 (0.047)*** |
| Education | |
| Master's & above (ref = Bachelor) | 1.110 (3.004) |
| SSC discipline | |
| Sciences (ref = Humanities/business) | 1.242 (3.46) |
| HSC discipline | |
| Sciences (ref = Humanities/business) | 1.544 (4.68) |
| Bachelor discipline | |
| Sciences (ref = Humanities/business) | −0.954 (0.385) |
| Teaching level | |
| Both SSC and HSC (ref = Either SSC or HSC) | −1.554 (0.211)* |
| Teaching experience | |
| >20 years (ref = <20 years) | 0.902 (2.464) |
| Hometown vulnerable to EWEs | |
| Yes (ref = No) | 0.549 (1.73) |
| Involvement in an environmental organization | |
| Yes (ref = No) | −0.722 (0.459) |
| Environment or CC courses completed | |
| Yes (ref = No) | −1.976 (0.139) |
| ***$p < 0.005$, **$p < 0.010$, *$p < 0.05$ | Observation used 95 |
| $R^2$ (Cox and Snell) = 31.2%; Chi-square = 32.3 | Classification 75.8% |

*Reference category: Fluctuating.*
*The symbol indicates *** is statistically significant at p = 0.005.*

who feel it is decreasing represent 48.1 and 43.8%, respectively, fluctuating, 30.34 and 37.5%; and increasing, 21.5 and 18.8%. In addition, the majority of teachers who teach at either the SSC or HSC level (58.9%) or both levels (72.7%) believe that temperatures are rising. Teachers who teach at only one of the levels are more likely to believe that temperatures are fluctuating (41.1%) than those who teach at both (27.3%). Teachers in both groups believe that precipitation is decreasing (45.2% for either SSC or HSC teachers and 54.5% for those who teach both), while some believe that temperatures are fluctuating (32.9% for the former, 27.3% for the latter) and others believe that precipitation is increasing (see **Table 3**).

## Vulnerability of Hometown to EWEs

We considered the vulnerability of respondents' hometown to extreme weather events (EWEs) to examine whether it is associated with changes in teachers' perceptions of climate change. We found that perceptions of temperature change did not differ significantly depending on whether respondents perceived their areas to be vulnerable to extreme weather events ($p > 0.05$). Perceptions about precipitation change, however, do vary significantly between the two groups ($p < 0.05$). **Table 3** shows that respondents who believe their hometown is at risk from EWEs and those who do not both perceive temperatures as increasing (56.4 and 70%, respectively). The former are more likely to think of temperature as fluctuating (43.6%) than the latter (30%). Regarding changes in precipitation patterns, most respondents in both categories believe it is decreasing (54.5 and 37.5%, respectively); others see it as varying (34.4 and 27.5%) or increasing (10.9 and 35.0%).

## Participation in Climate-Change-Related Programs

### Involvement in an Environmental Organization

**Table 3** shows no statistically significant relationship between respondents' perceptions about climate change and their involvement in an environmental organization ($p > 0.05$). Respondents who are involved in an environmental organization are more likely to believe that temperatures will fluctuate (54.5%) than increase (45.5%); those who are much more likely to believe that temperatures will rise (64.3%) than fluctuate (35.7%). The biggest shares of respondents who are or are not involved in environmental organizations believe that precipitation is decreasing (45.5 and 47.6%, respectively); others see it as fluctuating (27.3 and 32.1%) or increasing (27.3 and 20.2%).

### Climate-Change-Related Course Completion

The results illustrate that respondents' perceptions about climate change are not related to whether or not they have taken an environmental course ($p > 0.05$). **Table 3** also shows that 66.7 and 33.3% of respondents who have taken an environmental course believe that temperatures are fluctuating or rising, respectively. Of the respondents who have not taken such a course, 65.1% believe that it is rising and 34.9% that it is fluctuating. For precipitation, respondents who have taken such a course generally believe that precipitation fluctuates (55.6%); in contrast, those who have not tend to see it as decreasing (50.0%).

## Binary Logistic Regression Model of Perceived Temperature Changes

BLR analyses revealed that two predictors significantly explain the regression model for perceptions that temperatures are increasing: type of educational institution and teaching level. Teachers at public institutions are less likely to perceive temperature increases compared to those at private institutions. In addition, our findings also show that teachers who teach at both the SSC and HSC levels are less likely to perceive temperatures as increasing than those who teach at only one of those levels. Although other variables are not statistically significant, they have a significant likelihood ratio to explain the trend of association. We found that teachers who held a master's degree or higher are three times more likely to perceive temperatures as increasing than those with only a bachelor's degree (see **Table 4**).

## Multinomial Logistic Regression Model of Perceived Changes in Rainfall

MLR analyses revealed that four predictors explain the pattern of perceived change in rainfall: type of institution, bachelor-level study area, hometown vulnerable to EWEs, and completion of environmental or climate-change-related courses (see **Table 5**). Teachers with a science background in their undergraduate education were 18.8 times more likely to perceive rainfall as

**TABLE 5 |** Parameter estimates for perceived changes in rainfall.

| Explanatory variable | Overall significance of the variable (*p*) | Variables | Rainfall increasing | | Rainfall decreasing | |
|---|---|---|---|---|---|---|
| | | | Coefficient (Odds ratio) | *p* | Coefficient (Odds ratio) | *p* |
| Type of educational institution | 0.000** | Private = 0<br>Public = 1 | 1.443 (4.233) | $0.126^{ns}$ | −2.881 (17.83) | 0.000** |
| Educational level | 0.235 | Master's and above = 0<br>Bachelor =1 | 1.418 (4.129) | $0.131^{ns}$ | 0.194 (1.214) | $0.816^{ns}$ |
| SSC study area | 0.509 | Humanities/business = 0<br>Science = 1 | −1.261 (0.283) | $0.372^{ns}$ | −1.296 (0.274) | $0.307^{ns}$ |
| HSC study area | 0.718 | Humanities/business = 0<br>Science = 1 | −1.284 (0.277) | $0.427^{ns}$ | −1.190 (0.304) | $0.437^{ns}$ |
| Bachelor study area | 0.006** | Humanities/business = 0<br>Science = 1 | 2.939 (18.895) | 0.008** | −2.426 (11.31) | 0.021* |
| Teaching experience | 0.192 | 20 years or more = 0<br>Less than 20 years = 1 | −1.275 (0.280) | $0.215^{ns}$ | −1.485 (0.226) | $0.083^{ns}$ |
| Teaching level | 0.104 | Both SSC and HSC = 0<br>Either SSC or HSC = 1 | 0.594 (1.812) | $0.570^{ns}$ | 1.739 (5.691) | 0.048* |
| Hometown vulnerable to EWEs | 0.003** | No = 0<br>Yes = 1 | 0.676 (1.966) | $0.428^{ns}$ | −1.545 (0.213) | 0.026* |
| Involvement in an environmental organization | 0.320 | No = 0<br>Yes = 1 | −2.089 (0.124) | $0.187^{ns}$ | −1.533 (0.216) | $0.280^{ns}$ |
| Environment or CC courses completed | 0.008** | No = 0<br>Yes = 1 | 1.375 (3.955) | $0.414^{ns}$ | −3.816 (4.408) | 0.009** |
| Observation used 95; chi-square = 43.205; $R^2$ (Cox and Snell) = 36.5%; classification 67.4% | | | | | | |

*Notes: Reference level = Frequent fluctuation.*
*** = Highly significant ($p < 0.010$); * = Significant ($0.011 > p < 0.049$), $^{ns}$ = Not significant.*

increasing. Despite a negligible association, some predictors exhibit exceptional odds ratios to explain the trend of effects on the outcome variable. Teachers with a bachelor's degree are 4.1 times more likely to perceive rainfall as increasing than those with a postgraduate degree. Teachers with science experience in SSC and HSC are less likely to perceive that rainfall is increasing, as are teachers with <20 years of teaching experience compared to those with more. In addition, teachers who teach at the SSC or HSC level, who consider their hometown as vulnerable to EWEs, and who have taken an environmental or climate-change-related course are, respectively, 1.8, 1.9, and 3.9 times more likely to perceive that rainfall is increasing. Finally, teachers who are members of an environmental organization are less likely to think that rainfall is increasing.

Five predictors explain perceptions of declining precipitation: type of institution, undergraduate study area, teaching level, whether their hometown is vulnerable to EWEs, and whether they have taken courses related to the environment or climate change. Teachers at public institutions are less likely to feel that precipitation is decreasing. Teachers with a science background in their undergraduate education are 11.3 times less likely to perceive that rainfall is decreasing. In addition, teachers who teach in at either SSC or HSC level are 5.6 times more likely to perceive that precipitation is decreasing than those who teach in both. Teachers who said that their hometowns are vulnerable to EWEs are less likely to perceive that precipitation is decreasing, as are those who have taken courses on the environment and climate change.

## DISCUSSION

This study shows that teachers in both public and state schools and colleges are familiar with the term "climate change" and its meaning. In both primary and secondary schools in Bangladesh, there are science- or environment-related subjects that relate to climatic events. All teachers need to teach their students about climate challenges. They should also keep abreast of the latest developments in global climate change. We also found through this study that a large proportion of teachers often converse about current climate change issues with their colleagues, which is a useful source of information for understanding the concept. Similar results were found in other studies in Bangladesh (Huda, 2013; Kabir et al., 2016; Ahmed and Haq, 2019) and other countries (Yu et al., 2013; Abegaz and Wims, 2014). In contrast, Anik and Khan (2012) argue that a small proportion (10%) of

respondents in the northeastern region of Bangladesh had good knowledge of climate change.

Shahid et al. (2012) observed changing temperature and precipitation patterns in Bangladesh in studies. We asked our participants how they perceived temperature changes in their environment. Most public school teachers felt that the average temperature had increased, while most private school teachers perceived the temperature as fluctuating. There were also differences in perceptions about annual precipitation between the two groups of teachers. Private school teachers are more likely to perceive a decrease in precipitation than public school teachers. A significant number of teachers from both categories also perceive variations in precipitation (public: 44.7%, private: 22.8%). Many studies conducted in different parts of the world have also examined how local people perceive changes in temperature and precipitation patterns. In northern Thailand, Manandhar et al. (2014) found that the majority of participants perceived an increase in the amount of rainfall and a decrease in the number of rainy days over the past two decades. Most households noted that rainfall, which used to start in mid-April, was now starting later, in mid-May or June. Tiwari et al. (2010) also found that perceptions about rising temperatures were most commonly reported in Nepal. Similar results were also found in southern Ethiopia (Debela et al., 2015) and India (Shukla et al., 2015). Teachers in public schools are more likely to believe that humans are capable of coping with the effects of climate change. This result emerges from Morgado et al. (2017) survey in Portugal, Mexico, and Mozambique, where they found that the vast majority of respondents believe that humans can mitigate the effects of climate change (97–100%).

In this study, we examine how teachers' perceptions of climate change vary with their type of educational institution, disciplinary background, and personal experiences with climate change. We find that the type of institution and study areas in which they teach were significantly associated with their perceptions of changing temperature, and the type of institution in which they teach, the subject area of their undergraduate degree, their hometown's vulnerability to EWEs, and having taken environment- or climate-change-related courses explained statistically significant associations with their perceptions of precipitation change. We also found that public school teachers were less likely to perceive that temperatures were rising compared to private. Haq and Ahmed (2020) conducted a survey of university students and found that perceptions of climate change differed significantly depending on whether they were involved in an environmental organization or had taken an environment-related course. However, we found no statistically significant relationship between these factors and teachers' perceptions of climate change. We did find that teachers with a science background in their SSC and HSC were more likely to perceive temperatures as increasing, but if their science background was at the bachelor level they were less likely to perceive temperatures as increasing than their counterparts. We also found that length of teaching experience plays a role in explaining teachers' perceptions about climate change. Teachers with more than 20 years' experience are 2.4 times more likely to perceive a temperature rise than those with <20 years' experience, while the latter are less likely to perceive a decrease in precipitation than the former. One possible explanation for this result is that younger teachers are more interested in current and updated information. As a result, they are more aware of recent changes in temperature and precipitation in their area. These findings are similar to other studies (e.g., Beck et al., 2013; Ayanlade and Jegede, 2016; Mugambiwa and Dzomonda, 2018). Finally, teachers who consider their home area vulnerable to EWEs are 1.7 times more likely to observe temperatures as increasing than teachers who do not consider their home area vulnerable to EWEs.

## CONCLUSION

This study represents one of the few attempts to examine perceptions about climate change among teachers in schools and colleges in Bangladesh. Our findings can contribute to education policy in Bangladesh and can be compared to other cases in other South Asian countries. They demonstrate the importance of understanding the differences in teachers' perceptions of climate change based on their academic disciplinary background, their participation in climate change programs, and their experience of extreme weather events. We suggest that teachers be given ample opportunities to discuss various climate-related topics with their students, with proper instruction and guidance to be included in the curriculum. Moreover, efforts should be made to educate teachers on various climate issues by organizing seminars, conferences, etc., where local and international experts share their knowledge, experiences, and suggestions. This undeniably calls for a comparison of teachers' perceptions about climate change in a larger number of schools and colleges, and findings based on information gathered from a large sample could inform the inclusion of climate/environment-related courses at different educational levels and mandatory climate-change-related training for teachers. We acknowledge that one of the major limitations of the study is that it only covers and compares one public and two private schools/colleges. Our sample was thus too small to generalize about climate change perceptions among teachers at a variety of educational institutions. In addition, more research is also recommended focusing on country's the northern and southern regions, to reveal the difficulties more thoroughly. It is hoped that this kind of comparative research will help the relevant authorities and policymakers make decisions taking into account how the experience of different catastrophic events shapes perceptions about climate change and what should be done to mitigate the effects of climate change.

## DATA AVAILABILITY STATEMENT

The raw data supporting the findings of this article will not be made available by the authors. The authors informed respondents that the data will be confidential and that personal information will not be disclosed.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

SA: conception of the paper and project supervision. MA and MC: data collection, drafting of the abstract, introduction, discussion, and conclusion. SA, KA, and MA: article search and their organization and distribution for review. MA, KA, MC, and SA: article review (evenly split), article revision, and approval of the final version for submission. KA and SA: data analysis and article finalization. All authors contributed to the article and approved the revised version.

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## REFERENCES

Abegaz, D. M., and Wims, P. (2014). Extension agents' awareness of climate change in Ethiopia. *J. Agric. Educ. Ext.* 21, 479–495. doi: 10.1080/1389224X.2014.946936

Ahmed, K. J., Chowdhury, M. T. A., Ahmed, M. N. Q., and Haq, S. M. A. (2021). "Understanding climate change perception of teachers and students: an overview," in *Climate Vulnerability and Resilience in the Global South: Climate Change Management*, eds G. M. M. Alam, M. O. Erdiaw-Kwasie, G. J. Nagy, and W. Leal Filho (Cham: Springer), 395–408.

Ahmed, M. N. Q., and Haq, S. M. A. (2019). Indigenous people's perceptions about climate change, forest resource management, and coping strategies: a comparative study in Bangladesh. *Environ. Dev. Sustain.* 21, 679–708. doi: 10.1007/s10668-017-0055-1

Ahmed, Z., Hussain, A. H. M. B., Ambinakudige, S., Ahmed, M. N. Q., Alam, R., Rezoan, H. A., et al. (2022). Perceived human-induced causes of landslide in Chattogram metropolitan area in Bangladesh. *Earth Syst. Environ.* doi: 10.1007/s41748-022-00304-2

Alam, G. M. M., Alam, K., and Mushtaq, S. (2017). Climate change perceptions and local adaptation strategies of hazard-prone rural households in Bangladesh. *Clim. Risk Manag.* 17, 52–63. doi: 10.1016/j.crm.2017.06.006

Anik, S. I., and Khan, M. A. S. A. (2012). Climate change adaptation through local knowledge in the north eastern region of Bangladesh. *Mitig. Adapt. Strat. Gl.* 17, 879–896. doi: 10.1007/s11027-011-9350-6

Arini, A. T., Ghazali, R. J., Satiti, A., Kamali, M., and Yuniarti, K. W. (2017). Global climate change as perceived by elementary school teachers in Yogyakarta, indigenous psychology approach. *J. Psikologi* 44, 217–228. doi: 10.22146/jpsi.26132

Arslan, H. O., Cigdemoglu, C., and Moseley, C. (2012). A three-tier diagnostic test to assess pre-service teachers' misconceptions about global warming, greenhouse effect, ozone layer depletion, and acid rain. *Int. J. Sci. Educ.* 34, 1667–1686. doi: 10.1080/09500693.2012.680618

Ayanlade, A., and Jegede, M. O. (2016). Climate change education and knowledge among Nigerian university graduates. *Weather Clim. Soc.* 8, 465–473. doi: 10.1175/WCAS-D-15-0071.1

Babbie, E. (2004). *The Practice of Social Research, 10th Edn.* Belmont: Thomson Learning.

Bateman, T. S., and O'Connor, K. (2016). Felt responsibility and climate engagement: distinguishing adaptation from mitigation. *Glob. Environ. Chang.* 41, 206–215. doi: 10.1016/j.gloenvcha.2016.11.001

Beck, A., Sinatra, G. M., and Lombardi, D. (2013). Leveraging higher-education instructors in the climate literacy effort factors related to university faculty's propensity to teach climate change. *Int. J. Clim. Chang. Impac. Response* 4, 1–17. doi: 10.18848/1835-7156/CGP/v04i04/37181

Boon, H. J. (2016). Pre-service teachers and climate change: A stalemate? *Aust. J. Teacher Educ.* 41. doi: 10.14221/ajte.2016v41n4.3

Breslyn, W., Drewes, A., McGinnis, J. R., Hestness, E., and Mouza, C. (2017). Development of an empirically-based conditional learning progression for climate change. *Sci. Educ. Int.* 28, 214–223. doi: 10.33828/sei.v28.i3.5

Brody, S. D., Zahran, S., Vedlitz, A., and Grover, H. (2008). Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States. *Environ. Behav.* 40, 72–95. doi: 10.1177/0013916506298800

Brouder, P., and Lundmark, L. (2011). Climate change in Northern Sweden: intra-regional perceptions of vulnerability among winter-oriented tourism businesses. *J. Sustain. Tour.* 19, 919–933. doi: 10.1080/09669582.2011.573073

Bunce, M., Rosendo, S., and Brown, K. (2010). Perceptions of climate change, multiple stressors and livelihoods on marginal African coasts. *Environ. Dev. Sustain.* 12, 407–440. doi: 10.1007/s10668-009-9203-6

Carlton, S. J., and Jacobson, S. K. (2013). Climate change and coastal environmental risk perceptions in Florida. *J. Environ. Manag.* 130, 32–39. doi: 10.1016/j.jenvman.2013.08.038

Ceyhan, G. D., and Mugaloglu, E. Z. (2020). The role of cognitive, behavioral and personal variables of pre-service teachers' plausibility perceptions about global climate change. *Res. Sci. Technol. Educ.* 38, 131–145. doi: 10.1080/02635143.2019.1597695

Chowdhury, M. T. A., Ahmed, K. J., Ahmed, M. N. Q., and Haq, S. M. A. (2021). How do teachers' perceptions of climate change vary in terms of importance, causes, impacts and mitigation? A comparative study in Bangladesh. *SN Soc. Sci.* 1, 174. doi: 10.1007/s43545-021-00194-7

de Jong, V. M. T., Eijkemans, M. J. C., van Calster, B., Timmerman, D., Moons, K. G. M., Steyerberg, E. W., et al. (2019). Sample size considerations and predictive performance of multinomial logistic prediction models. *Statist. Med.* 38, 1601–1619. doi: 10.1002/sim.8063

Debela, N., Mohammed, C., Bridle, K., Corkrey, R., and McNeil, D. (2015). Perception of climate change and its impact by smallholders in pastoral/agropastoral systems of Borana, South Ethiopia. *SpringerPlus* 4, 236. doi: 10.1186/s40064-015-1012-9

Department for Education (2015). *National Curriculum in England: Science Programmes of Study*. Available online at: https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study/national-curriculum-in-england-science-programmes-of-study (accessed July 28, 2021).

Dessai, S., and Sims, C. (2010). Public perception of drought and climate change in southeast England. *Environ. Hazards* 9, 340–357. doi: 10.3763/ehaz.2010.0037

Ennes, M., Lawson, D. F., Stevenson, K. T., Peterson, M. N., and Jones, M. G. (2021). It's about time: perceived barriers to in-service teacher climate change professional development. *Environ. Educ. Res.* 27, 762–778. doi: 10.1080/13504622.2021.1909708

Eze, E. (2020). Socio-graphic analysis of climate change awareness and pro-environmental behaviour of secondary school teachers and students in Nsukka Local Government Area of Enugu State, Nigeria. *Int. Res. Geogr. Envir. Educ.* 29, 89–105. doi: 10.1080/10382046.2019.1657683

FAO (2007). *Adaptation to Climate Change in Agriculture, Forestry and Fisheries: Perspective, Framework and Priorities*. Rome: Food and Agriculture Organization of the United Nations. Available online at: https://www.fao.org/3/au030e/au030e.pdf (accessed May 11, 2021).

Foguesatto, C. R., Artuzo, F. D., Talamini, E., and Machado, J. A. D. (2018). Understanding the divergences between farmer's perception and meteorological records regarding climate change: a review. *Environ. Dev. Sustain.* 22, 1–16. doi: 10.1007/s10668-018-0193-0

Garai, J. (2014). "The impacts of climate change on the livelihoods of coastal people in Bangladesh: a sociological study," in *International Perspectives on Climate Change, Climate Change Management Series*, eds W. Leal Filho, F. Alves, S. Caeiro, and U. M. Azeiteiro (Cham: Springer), 151–163.

Gebrehiwot, T., and van der Veen, A. (2013). Farm level adaptation to climate change: the case of farmer's in the Ethiopian highlands. *Environ. Manage.* 52, 29–44. doi: 10.1007/s00267-013-0039-3

Glackin, M. (2016). "Risky fun" or "authentic science"? How teachers' beliefs in?uence their practice during a professional development programme on outdoor learning. *Int. J. Sci. Educ.* 38, 409–433. doi: 10.1080/09500693.2016.1145368

Haq, S. M. A., and Ahmed, K. J. (2017). Does the perception of climate change vary with the socio-demographic dimensions? A study on vulnerable populations in Bangladesh. *Nat. Hazards* 85, 1759–1785. doi: 10.1007/s11069-016-2664-7

Haq, S. M. A., and Ahmed, K. J. (2020). Perceptions about climate change among university students in Bangladesh. *Nat. Hazards* 103, 3683–3713. doi: 10.1007/s11069-020-04151-0

Hargreaves, I., Lewis, J., and Speers, T. (2003). *Towards a Better Map: Science, the Public and the Media*. London: Economic and Social Research Council.

Herman, B. C., Feldman, A., and Vernaza-Hernandez, V. (2017). Florida and Puerto Rico secondary science teachers' knowledge and teaching of climate change science. *Int. J. Sci. Math. Educ.* 15, 451–471. doi: 10.1007/s10763-015-9706-6

Hestness, E., McDonald, R. C., Breslyn, W., McGinnis, J. R., and Mouza, C. (2014). Science teacher professional development in climate change education informed by the Next Generation Science Standards. *J. Geosci. Educ.* 62, 319–329. doi: 10.5408/13-049.1

Higde, E., Oztekin, C., and Sahin, E. (2017). Turkish pre-service science teachers' awareness, beliefs, values, and behaviours pertinent to climate change. *Int. Res. Geogr. Environ. Educ.* 26, 253–263. doi: 10.1080/10382046.2017.1330040

Huda, M. N. (2013). Understanding indigenous people's perception on climate change and climatic hazards: a case study of Chakma indigenous communities in Rangamati Sadar Upazila of Rangamati District, Bangladesh. *Nat. Hazards* 65, 2147–2159. doi: 10.1007/s11069-012-0467-z

Huq, S., and Rabbani, M. G. (2015). "Climate adaptation technologies in agriculture and water supply and sanitation practice in the coastal region of Bangladesh," in *Climate Change and the Coast: Building Resilient Communities*, eds B. C. Glavovic, M. Kelly, R. Kay, and A. Travers (London: CRC Press), 142–170.

Intergovernmental Panel on Climate Change (IPCC) (2007). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, eds S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller (Cambridge; New York, NY: Cambridge University Press), 996.

Islam, A. R. M. T., Tasnuva, A., Sultana, S., and Rumana, S. (2014). Climate change impact: food production and local perception. *Am. J. Environ. Protect.* 3, 45–50. doi: 10.11648/j.ajep.20140302.11

Japanese National Commission for UNESCO (2012). *Guidelines for the UNESCO Associated Schools in Japan*. Available online at: http://www.mext.go.jp/en/unesco/title04/detail04/1373242.htm (accessed July 11, 2021).

Kabir, A., Ali, R., Islam, M. S., Kawsar, L. A., and Islam, M. A. (2009). A comparison of regional variations of fertility in Bangladesh. *Int. Q. Commun. Health Educ.* 29, 275–291. doi: 10.2190/IQ.29.3.f

Kabir, M., Rahman, M. B., Smith, W., Lusha, M., Azim, S., and Milton, A. (2016). Knowledge and perception about climate change and human health: findings from a baseline survey among vulnerable communities in Bangladesh. *BMC Public Health* 16, 1–10. doi: 10.1186/s12889-016-2930-3

Kahan, D. M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L. L., Braman, D., et al. (2012). The polarizing impact of science literacy and numeracy on perceived climate change risks. *Nat. Clim. Change* 2, 732–735. doi: 10.1038/nclimate1547

Karmalkar, A., McSweeney, C., New, M., and Lizcano, G. (2012). *UNDP Climate Change Country Profiles: Bangladesh*. Available online at: https://www.geog.ox.ac.uk/research/climate/projects/undp-cp/UNDP_reports/Bangladesh/Bangladesh.hires.report.pdf (accessed April 6, 2021).

Lambert, J. L., and Bleicher, R. E. (2013). Climate change in the preservice teacher's mind. *J. Sci. Teacher Educ.* 24, 999–1022. doi: 10.1007/s10972-013-9344-1

Manandhar, S., Pratoomchai, W., Ono, K., Kazama, S., and Daisuke, K. (2014). Local people's perceptions of climate change and related hazards in mountainous areas of northern Thailand. *Int. J. Disast. Risk Reduct.* 11, 47–59. doi: 10.1016/j.ijdrr.2014.11.002

Mansour, N. (2013). Consistencies and inconsistencies between science teachers' beliefs and practices. *Int. J. Sci. Educ.* 17, 1230–1275. doi: 10.1080/09500693.2012.743196

Meilinda, M., Rustaman, N. Y., and Tjasyono, B. (2017). The perceptions of pre-service science teachers and science teachers about climate change. *J. Pendidikan IPA Indonesia* 6, 292–397. doi: 10.15294/jpii.v6i2.9490

Mildenberger, M., Lubell, M., and Hummel, M. (2019). Personalized risk messaging can reduce climate concerns. *Glob. Environ. Chang.* 55, 15–24. doi: 10.1016/j.gloenvcha.2019.01.002

Morgado, F., Bacelar-Nicolau, P., Osten, J. R. V., Santos, P., Bacelar-Nicolau, L., Farooq, H., et al. (2017). Assessing university student perceptions and comprehension of climate change (Portugal, Mexico and Mozambique). *Int. J. Clim. Change Strat. Manage.* 9, 316–336. doi: 10.1108/IJCCSM-08-2016-0123

Mostafa, M. M. (2007). Gender differences in Egyptian consumers' green purchase behaviour: the effects of environmental knowledge, concern and attitude. *Int. J. Consum. Stud.* 31, 220–229. doi: 10.1111/j.1470-6431.2006.00523.x

Mugambiwa, S. S., and Dzomonda, O. (2018). Climate change and vulnerability discourse by students at a South African university. *Jàmbá J. Disast. Risk Stud.* 10, 476. doi: 10.4102/jamba.v10i1.476

NGSS Lead States (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: The National Academies Press.

Plutzer, E., McCaffrey, M., Hannah, A. L., Rosenau, J., Berbeco, M., and Reid, A. H. (2016). Climate confusion among U.S. teachers. *Science* 351, 664–665. doi: 10.1126/science.aab3907

Pouliotte, J., Smit, B., and Westerhoff, L. (2009). Adaptation and development: livelihoods and climate change in Subarnabad, Bangladesh. *Clim. Dev.* 1, 31–46. doi: 10.3763/cdev.2009.0001

Rahman, M. R., Lateh, H., and Islam, M. N. (2018). "Climate of bangladesh: Temperature and rainfall changes, and impact on agriculture and groundwater-a gis-based analysis," in *Bangladesh I: Climate Change Impacts, Mitigation and Adaptation in Developing Countries*, eds M. Islam, and A. van Amstel (Cham: Springer). doi: 10.1007/978-3-319-26357-1_2

Salick, J., and Byg, A. (eds.). (2007). *Indigenous Peoples and Climate Change. Oxford: Tyndall Centre for Climate Change Research*. Available online at: https://library.uniteddiversity.coop/Climate_Change/Indigenous_Peoples_and_Climate_Change.pdf (accessed June 16, 2021).

Salick, J., Zhendong, F., and Byg, A. (eds.). (2009). Eastern Himalayan alpine plant ecology, Tibetan ethnobotany, and climate change. *Glob. Environ. Change* 19:147–155. doi: 10.1016/j.gloenvcha.2009.01.008

Sarker, M. A. R., Alam, K., and Gow, J. (2012). Exploring the relationship between climate change and rice yield in Bangladesh: an analysis of time series data. *Agric. Sys.* 112, 11–16. doi: 10.1016/j.agsy.2012.06.004

Seow, T., and Ho, L. C. (2016). Singapore teachers' beliefs about the purpose of climate change education and student readiness to handle controversy. *Int. Res. Geogr. Environ. Educ.* 25, 358–371. doi: 10.1080/10382046.2016.1207993

Shahid, S., Harun, S. B., and Katimon, A. (2012). Changes in diurnal temperature range in Bangladesh during the time period 1961–2008. *Atmos. Res.* 118, 260–270. doi: 10.1016/j.atmosres.2012.07.008

Shukla, G., Kumar, A., Pala, N. A., and Chakravarty, S. (2015). Farmers perception and awareness of climate change: a case study from Kanchandzonga Biosphere Reserve, India. *Environ. Dev. Sustain.* 18, 1167–1176. doi: 10.1007/s10668-015-9694-2

Smith, W. J. Jr., Liu, Z., Safi, A. S., and Chief, K. (2014). Climate change perception, observation and policy support in rural Nevada: a comparative analysis of Native Americans, non-native ranchers and farmers and mainstream America. *Environ. Sci. Policy* 42, 101–122 doi: 10.1016/j.envsci.2014.03.007

Speranza, C. I., Kiteme, B., Ambenje, P., Wiesmann, U., and Makali, S. (2010). Indigenous knowledge related to climate variability and change: insights from droughts in semi-arid areas of former Makueni District, Kenya. *Clim. Change* 100, 295–315. doi: 10.1007/s10584-009-9713-0

Stevenson, K. T., Peterson, M. N., and Bradshaw, A. (2016). How climate change beliefs among U.S. teachers do and do not translate to students. *PLoS ONE* 11, e161462. doi: 10.1371/journal.pone.0161462

Taylor, A., de Bruin, W. B., and Dessai, S. (2014). Climate change beliefs and perceptions of weather-related changes in the United Kingdom. *Risk Anal.* 34, 1995–2004. doi: 10.1111/risa.12234

Thomas, T. S., Mainuddin, K., Chiang, C., Rahman, A., Haque, A., Islam, N., et al. (2013). *Agriculture and Adaptation in Bangladesh: Current and Projected Impacts of Climate Change.* IFPRI Discussion Paper 01281. International Food Policy Research Institute. Available online at: http://www.ifpri.org/sites/default/files/publications/ifpridp01281.pdf (accessed June 2, 2021).

Tiwari, K. R., Awasthi, K. D., Balla, M. K., and Sitaula, B. K. (2010). Local people's perception on climate change, its impact and adaptation practices in Himalaya to Terai regions of Nepal. *Himal. J. Dev. Democr.* 5, 56–63. Available online at: http://repository.unm.edu/bitstream/handle/1928/11324

Tripathi, A., and Mishra, A. K. (2017). Knowledge and passive adaptation to climate change: an example from Indian farmers. *Clim. Risk Manag.* 16, 195–207. doi: 10.1016/j.crm.2016.11.002

Turner, W. R., Oppenheimer, M., and Wilcove, D. S. (2009). A force to fight global warming. *Nature* 462, 278–279. doi: 10.1038/462278a

UNESCO (2010). *Climate Change Education for Sustainable Development: The UNESCO Climate Change Initiative*. Paris: UNESCO. Available online at: https://unesdoc.unesco.org/ark:/48223/pf0000190101 (accessed May 22, 2021).

Van den Ban, A. W., and Hawkins, H. S. (2000). *Agricultural Extension, 2nd Edn.* Oxford: Blackwell Science.

Verchot, L. V., Noordwijk, M. V., Kandji, S., Tomich, T., Ong, C., Albrecht, A., et al. (2007). Climate change: linking adaptation and mitigation through agroforestry. *Mitig. Adapt. Strat. Glob. Change* 12, 901–918. doi: 10.1007/s11027-007-9105-6

Weber, E. U., and Stern, P. C. (2011). Public understanding of climate change in the United States. *Am. Psychol.* 66, 315–328. doi: 10.1037/a0023253

YouGov (2019) *YouGov/Oxfam UKSCN Climate Crisis.* Available online at: https://d25d2506sfb94s.cloudfront.net/cumulus_uploads/document/i6swtiz9ta/YG-Archive-02012020-OxfamClimateCrisis.pdf (accessed July 20, 2021).

Yu, H., Wang, B., Zhang, Y. J., Wang, S., and Wei, Y. M. (2013). Public perception of climate change in China: results from the questionnaire survey. *Nat. Hazards* 69, 459–472. doi: 10.1007/s11069-013-0711-1

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